Tycho made a good determination of the length of the tropical year, his error being only 1 second. He also obtained a good value of the constant of precession, by comparison of his results with those of Hipparchus and Ptolemy; he was able to show that the large "trepidations" or fluctuations in this motion, that were previously believed to exist, were wholly illusory.

Tables of the sun are given in the volume, the data extending to the year 1800. The annual advance of the perigee is taken as 45″, the true value being 61″. A short table of astronomical refraction is given; Tycho was one of the first to investigate this correction; his value 34′ for the horizontal refraction agrees with modern authorities, but he gives 5″ instead of 57″ for the value at 45° altitude. The erroneous assumption of 3′ for the solar parallax vitiated the refractions that were based on solar observations. Tycho's instruments were capable of proving that the true value was much smaller, but it never occurred to him to suspect the accepted value.

The section on the moon is specially interesting, for Tycho added important facts to our knowledge of its motion. He was an independent discoverer of the "variation," even if we admit the doubtful claim of Abul Wefa to be the first discoverer; in any case his writings were unknown in Europe until long after Tycho's time. Tycho also discovered the important "annual equation," and drew attention to the "reduction" arising from the inclination of the moon's path to the ecliptic. The mean values for the parallax and semidiameter adopted by Tycho, 60′ 51″ and 17′ 0″ respectively, are both too great, and further from the truth than the values 58′ 25″ and 16′ 25″ previously adopted by Copernicus. The latter, however, adopted an eccentricity double the true value, and Tycho greatly improved this element. Lunar tables are given in the volume, and their use illustrated by calculations of the details of the eclipses of the sun and moon that occurred near the end of the year 1601.

The chapter on the determination of the coordinates of the fixed stars opens with an account of the methods previously employed for connecting their places with that of the sun. The moon had generally been employed as an intermediary, either when visible in daylight, or when eclipsed, it being obviously practicable to connect the longitude of the shadow on the moon with that of the sun. Tycho used Venus as an intermediary; he found it possible to observe it in daylight when at its greatest brilliancy; the fact of its parallax, semidiameter, and motion being much smaller than those of the moon were great advantages. His star observations are astonishingly good, considering that no optical aid was available in his day; for example, fifteen values of the right ascension of Alpha Arietis, made between 1582 and 1587, and reduced to the end of 1585, range from 26° 0′ 4″ to 26° 0′ 44″, the mean value being 26° 0′ 29″, only 19″ less than the value calculated from modern data. Such work compares favourably with some that was done after the invention of the telescope, and it must be remembered that Tycho was ignorant of the existence of nutation and aberration.

He selected Alpha Arietis as the "Lapis Angularis" of his celestial structure, its proximity to the vernal equinox rendering it convenient for this purpose. A short list of fundamental stars, mainly in the Zodiac, have their places determined with special care. Then is given a less accurate catalogue of the longitudes and latitudes of about 800 stars for the epoch 1600. This must have been a great boon to his contemporaries, as the existing star catalogues were very inaccurate. A hundred bright stars have their right ascension and declination given for 1600 and 1700.

The reprint follows the original closely in type and pagination, the illustrations being reproduced in facsimile. They include diagrams of the instruments, which claim the admiration of astronomers, as the source of the observations from which Kepler deduced the laws of planetary motion.

The work is enriched with some annotations by Dr. Dreyer, directing attention to slips and inaccuracies in Tycho's text, or giving further information on various matters of interest.

ANDREW C. D. CROMMELIN.

PLANT-BREEDING.

Plant-breeding. By Prof. L. H. Bailey. New edition, revised by Arthur W. Gilbert. Pp. xviii + 474. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1915.) Price 8*s.* 6*d.* net.

THE new edition of Prof. Bailey's text-book of plant-breeding contains a good deal of fresh matter. The work first appeared in the time when no order had been perceived in the phenomena of variation or heredity, and chapters by Dr. Gilbert are introduced dealing with the recent discoveries. These sections of the book are well done so far as they go, but though various parts have been rewritten, signs of irregular growth remain, as is, indeed, in such cases unavoidable.

In his preface Prof. Bailey expresses with some frankness a regret that with the new knowledge the old simplicity of ignorance has been troubled,

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and strict criticism would therefore be scarcely in place.

The book still serves what was doubtless its first purpose—to excite curiosity regarding the nature and origin of plant varieties and to suggest the enormous possibilities which still lie before the plant breeder. Special reference might have been made, in this connection, to tropical products. Few, for example, have yet realised what incalculable additions to the world's wealth can yet be made by simple means. Rubber trees, for instance, vary at least 200 per cent. in yield, and it is with amazement that a plant-breeder learns that the planters are content to sow, without regard to breeding or quality, trees which are to last many years. To a less degree this is true of cocoanuts and many other objects of tropical agriculture. The chapter on the vast progress made in the teaching and investigation of plant-breeding in the United States gives evidence that this neglect will not long continue. The practical hints might well be amplified. Nothing is said, for example, of the method of removing pollen by a water-jet, though this device was, by the way, an American invention. More curious is the silence on the subject of self-sterility, a phenomenon which, whether as an obstacle or a help, plays so large a part in the daily experience of every plant-breeder.

The author's theoretical views are occasionally novel. In particular, the statement is made that individuality in plants is something quite distinct from what it is in animals. This proposition might with value be developed in an essay elucidating some of the essential phenomena of variation, but it is by no means a self-evident truth, to say no more. From the long list of periodicals dealing more or less with the subject, the *Zeitschrift für Induktive Vererbungsund Abstammungslehre,* though by far the most important continental journal, has by some accident been omitted.

THE BRITISH RAINFALL ORGANISATION.

British Rainfall, 1914: *on the Distribution of Rain in Space and Time over the British Isles during the year* 1914. By Dr. H. R. Mill and C. Salter. 54th annual volume. Pp. 448. (London: E. Stanford, Ltd., 1915.) Price 10*s*.

THE volume contains the records of about 5500 observers in Great Britain and Ireland, and there are various articles associated with rainfall. A paper on isomeric rainfall maps of the British Isles was contributed by the director of the British Rainfall Organisation to the Royal Meteorological Society in November, 1914, and the present volume contains a summary of the paper with the monthly and seasonal maps. A frontispiece in colour shows the relation of the rainfall in 1914 to the average of 1875–1909. The distribution of rainfall in time is dealt with in various ways from the ordinary daily records. For the occurrence of rain days, droughts, and rain spells over the British Isles one hundred stations have been selected, distributed uniformly over the country. The number of rain days are given in a tabular form for each month, and graphically for the average 1892–1911 and for the year 1914.

The year may be regarded as one of average rainfall frequency in all parts of the country, with generally fewer rain days in the summer and more in the winter than in a normal year. Absolute and partial droughts are discussed; the former is represented by a period of more than fourteen consecutive days, no one of which is a rain day, while a partial drought is a period of more than twenty-eight consecutive days, the mean rainfall of which does not exceed 0·01 in. per day. A rain-spell is practically the antithesis of an absolute drought, and is a period of more than fourteen consecutive days, every one of which is a rain day; the number of rain-spells in 1914 compared with the average was slightly deficient. Monthly, yearly, and seasonal rainfalls are given in a tabular form and graphically; for the British Isles as a whole the rainfall in 1914 was 7 per cent. more than the average.

The Meteorological Office having introduced a new system of units for the official records of British meteorology, the British Rainfall Organisation has fallen into line, and has adopted the use of the millimetre as the unit for measuring the depth of rain. The annual total rainfall for all the stations is given both in millimetres and inches, and this addition has involved the widening of the page of publication. The difficulty as to a change in the definition of a rain day consequent on the use of the metric units has been postponed to next year, and no alteration in this respect has been introduced in the present volume.

Notwithstanding many difficulties arising directly and indirectly from the war, the rainfall work has been carried out in all its details, although the exigencies of the times have caused some reduction of staff, and naturally the income has dropped. Greater stress is expected next year, and a hope is expressed that the rainfall records, so essential to the good of the country, will not suffer. An effort is being made to augment the voluntary funds by the aid of which the work is carried on, but public funds are not at present available, and the Treasury has decided that in the circumstances no action can be taken,

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